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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
09/481,771	01/11/2000	Karl Michael Isham	PHA 23,656	6085

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EXAMINER

ALI, SYED J

ART UNIT	PAPER NUMBER
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2127

DATE MAILED: 03/20/2003

5

Please find below and/or attached an Office communication concerning this application or proceeding.

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Office Action Summary

Application No.

09/481,771

Applicant(s)

ISHAM, KARL MICHAEL

Examiner

Syed J Ali

Art Unit

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-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133).
- Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

- 1) ☐ Responsive to communication(s) filed on ____.
- 2a) ☐ This action is FINAL. 2b) ☒ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

- 4) ☒ Claim(s) 1-25 is/are pending in the application.
- 4a) Of the above claim(s) ____ is/are withdrawn from consideration.
- 5) ☐ Claim(s) ____ is/are allowed.
- 6) ☒ Claim(s) 1-3,6-10,13-18 and 21-25 is/are rejected.
- 7) ☒ Claim(s) 4,5,11,12,19 and 20 is/are objected to.
- 8) ☐ Claim(s) ____ are subject to restriction and/or election requirement.

Application Papers

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☐ The drawing(s) filed on ____ is/are: a) ☐ accepted or b) ☐ objected to by the Examiner.
- Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
- 11) ☐ The proposed drawing correction filed on ____ is: a) ☐ approved b) ☐ disapproved by the Examiner.
- If approved, corrected drawings are required in reply to this Office action.
- 12) ☐ The oath or declaration is objected to by the Examiner.

Priority under 35 U.S.C. §§ 119 and 120

- 13) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☐ All b) ☐ Some * c) ☐ None of:
1. ☐ Certified copies of the priority documents have been received.
2. ☐ Certified copies of the priority documents have been received in Application No. ____.
3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).
- * See the attached detailed Office action for a list of the certified copies not received.
- 14) ☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. § 119(e) (to a provisional application).
- a) ☐ The translation of the foreign language provisional application has been received.
- 15) ☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. §§ 120 and/or 121.

Attachment(s)

- 1) ☒ Notice of References Cited (PTO-892)
- 2) ☒ Notice of Draftsperson's Patent Drawing Review (PTO-948)
- 3) ☒ Information Disclosure Statement(s) (PTO-1449) Paper No(s) 4.
- 4) ☐ Interview Summary (PTO-413) Paper No(s). ____.
- 5) ☐ Notice of Informal Patent Application (PTO-152)
- 6) ☐ Other: _____

DETAILED ACTION

Claim Rejections - 35 USC § 112

1. The following is a quotation of the second paragraph of 35 U.S.C. 112:

The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the applicant regards as his invention.

2. Claims 2, 9, and 17 are rejected under 35 U.S.C. 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention.

Claim 2 recites the limitations "task_r" in lines 23 and 25, "C_r" in line 24, and "task_U" in line 26. There is insufficient antecedent basis for these limitations in the claim

Claim 9 recites the limitations "task_r" in lines 11 and 13, "C_r" in line 12, and "task_U" in line 14. There is insufficient antecedent basis for these limitations in the claim.

Claim 17 recites the limitations "task_R" in line 10, "C_r" in line 15, and "task_U" in line 17. There is insufficient antecedent basis for these limitations in the claim.

Claim Rejections - 35 USC § 103

1. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

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(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

2. Claims 1-3, 6-10, 13-18, and 21-25 are rejected under 35 U.S.C. 103(a) as being unpatentable over Yue et al. (USPN 6,272,517) (hereinafter Yue) in view of Sha et al. (see attached citation on form PTO-892) (hereinafter Sha).

As per claim 1, Yue discloses a method for sharing execution capacity among tasks executing in a real-time computing system having a performance specification in accordance with Rate Monotonic Analysis (RMA), comprising the steps of:

pairing a higher priority task with a lower priority task (col. 10 lines 27-41, "The thread in the same process can also be a thread in the same process having a highest execution priority", wherein the execution time allotted to a blocked thread is given to another thread of the highest priority);

reallocating execution time from the lower priority task to the higher priority task (col. 10 lines 27-41, "when a consumer thread is blocked, its remaining execution time is assigned to another thread in the same process", wherein it is noted that this does not apply to an overload condition, and this will be discussed below);

Yue does not specifically teach that reallocation of execution time occurs in response to an overload condition or increasing the period of the lower priority task to compensate for said reallocated execution time. Sha discloses transforming the execution period of a task in response to an overload condition (pg. 258-9, "We consider a scheduling algorithm to be stable if there exists a set of critical tasks such that all tasks in the set will meet their deadlines even if the processor is overloaded", "The period

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transformation technique can be used to ensure high utilization while meeting the deadline of an important, long-period task"). Sha also teaches that period transformation may not alter the utilization to the point where tasks may miss their deadline (pg. 259, "total task utilization cannot be increased above U_{\max} without missing a deadline"). Therefore, "Official Notice" is taken that it would have been obvious to one of ordinary skill in the art to increase the period of the lower priority task since the act of borrowing execution time from a lower priority task would increase the task utilization, defined as C_n / T_n since the value of C_n would increase. Therefore, the period of the lower priority task would have to be increased in order to ensure that the total task utilization of the two tasks combined does not affect the utilization bound.

Further, it would have been obvious to one of ordinary skill in the art to combine Yue with Sha since Yue allows a process to borrow execution time from another task, while Sha allows for the period of execution of a task to be altered. In combination, Yue and Sha provide a way of lending execution time between tasks, while ensuring that the total task utilization for the two tasks remains below an upper bound value based on Rate Monotonic Analysis.

As per claim 2, the combination of Yue and Sha fails to teach the method of claim 1, wherein an amount of said execution time available to loan from said lower priority task, $task_R$, to said higher priority task, $task_u$, is obtained as follows:

$$N_u = (N_r * T_u) / T_r$$

where,

N_r = amount of execution time to borrow from $task_r$, where $N_r < C_r$,

T_r = period of task_r, and

T_u = period of task_u.

However, as was established in the discussion of claim 1, it would have been obvious to one of ordinary skill to borrow execution time from one task and lend it to another to ensure that a deadline is met. Since the task utilization of any one task is defined by Sha (pg. 245) to be C_n / T_n , certain modifications to that formula must occur if execution time is being taken away. C_n is defined as the worst-case execution time of a particular task, and T_n is the period of that task. When borrowing execution time, a certain amount of execution time must be added to C_n for the task borrowing the time, and a certain amount of execution time must be subtracted from C_n for the task lending the time. Sha discusses that total task utilization should remain below an upper bound (pg. 259). By assuring that the total task utilization for the two tasks combined is to remain constant, it is a simple derivation of to arrive at the formula that is claimed, and one that would have been obvious to one of ordinary skill in mathematics. Therefore, "Official Notice" is taken that it would have been obvious to one of ordinary skill in the art to define the amount of execution time as above, based on the task utilization bounds defined in Sha (pg. 245) and the idea that the total combined task utilization should remain a constant.

As per claim 3, the combination of Yue and Sha fails to teach the method of claim 1, wherein said increased period of the lower priority task, task_r, is obtained as follows:

$$T_n = (C_r * T_r) / (C_r - N_r)$$

where

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 C_r = worst-case task execution time of task_r, T_r = period of task_r, and N_r = amount of execution time to borrow from task_r, where $N_r < C_r$.

As discussed thoroughly regarding claims 1 and 2, any alterations in the execution time or period of a particular task has to be accounted for such that the total task utilization does not exceed the bounds defined for the number of tasks running. As such, when execution time is lent to another task of a higher priority, a compensation needs to occur by increasing the period of the task lending the time such that the total utilization for both tasks remain a constant. Thus, the expression $(C_r / T_r) + (C_u / T_u) = [(C_r - N_r) / T_n] + [(C_u + N_u) / T_u]$ is the logical result that would allow the total task utilization for the two combined tasks to remain a constant based on Theorem 1 of Sha (pg. 245). Further, the value of T_n , the new period for the lower priority task, can be solved for using Theorem 1 of Sha and the formula arrived at in claim 2.

As per claim 6, Sha teaches the method of claim 1, wherein said higher priority task has hard deadlines (pg. 259, "period transformation technique can be used to ensure high utilization while meeting the deadline of an important, long-period task", wherein stating that an important task must meet its deadline is analogous to giving it a hard deadline in a real time system).

As per claim 7, the combination of Yue and Sha fails to teach the method of claim 1, wherein said lower priority task has soft deadlines. However, "Official Notice" is taken that it would have been obvious to one of ordinary skill in the art that the execution

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time should be borrowed from a task which has a soft deadline, since taking away execution time from that task increases the likelihood of that task not completing in its allotted period. By taking the execution time from a task that is not critical, the scheduler can ensure that a task with a hard deadline will complete without sacrificing another task with a hard deadline missing its deadline.

As per claim 8, Yue discloses a method for allocating resources among tasks executing in a real-time computing system having a performance specification in accordance with Rate Monotonic Analysis (RMA), comprising the steps of:

pairing a higher priority task with a lower priority task (col. 10 lines 27-41, "The thread in the same process can also be a thread in the same process having a highest execution priority", wherein the execution time allotted to a blocked thread is given to another thread of the highest priority); and

reallocating a portion of said first resource allocation from said lower priority task to said higher priority task when said higher priority task is operable (col. 10 lines 27-41, "when a consumer thread is blocked, its remaining execution time is assigned to another thread in the same process").

Yue fails to teach providing a first resource allocation to said lower priority task during a normal operating condition. Sha does disclose allocation of the resource during normal conditions (pg. 245 Theorem 1, wherein C_i is the worst-case execution time for that the task and T_i is the period of execution allotted to the task); and

It is noted that this claim differs from claim 1 in the sense that the reallocation of resources is not necessarily in response to an overload condition. However, the intention

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of the combination of Yue and Sha is to ensure that high priority tasks complete by their deadlines. In this sense, there may be times when a reallocation is necessary for the simple reason that a task with a hard deadline may miss its deadline simply because it has not been allocated enough execution time to complete by the deadline. In this case, execution time can still be loaned, in accordance with what is discussed in claim 1, to ensure that the deadline is met, even though the system may not necessarily be experiencing an overload condition. Therefore, the combination of Yue and Sha are still operable to ensure that the deadline is met, as discussed for claim 1. The motivation for combining these references can also be found in the discussion for claim 1.

As per claim 9, it is rejected for similar reasons as stated for claim 2.

As per claim 10, it is rejected for similar reasons as stated for claim 3.

As per claim 13, it is rejected for similar reasons as stated for claim 6.

As per claim 14, it is rejected for similar reasons as stated for claim 7.

As per claim 15, Yue teaches a method for sharing execution capacity among tasks executing in a real-time computing system having a performance specification in accordance with Rate Monotonic Analysis (RMA), comprising the steps of:

pairing a higher priority task, $task_u$, with a lower priority task, $task_r$ (col. 10 lines 27-41, "The thread in the same process can also be a thread in the same process having a

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highest execution priority”, wherein the execution time allotted to a blocked thread is given to another thread of the highest priority);

reallocating execution time from the lower priority task to the higher priority task during an overload condition (col. 10 lines 27-41, “when a consumer thread is blocked, its remaining execution time is assigned to another thread in the same process”, wherein it is noted that this does not apply to an overload condition, and this will be discussed below).

Sha teaches increasing the utilization of a higher priority task (this is achieved inherently as the utilization for a task is defined by Sha on pg. 245 as C_i / T_i , wherein C_i is the worst case execution time. If execution time is added to C_i then it follows that $(C_i + x) / T_i$, where x is the added execution time will have a higher value and thus an increased utilization). Sha also teaches decreasing the utilization of the lower priority task proportionally (pg. 259, “total task utilization cannot be increased above U_{\max} without missing a deadline”).

As discussed above for claim 1, the act of increasing the period of a task also decreases the utilization of that same task. Therefore, the statement of Sha that “total task utilization cannot be increased above U_{\max} without missing a deadline” indicates that if the utilization of the higher priority task is increased, the utilization of the lower priority task should be decreased by a proportional amount.

As per claim 16, the combination of Yue and Sha fails to teach the method of claim 15, wherein said utilizations of said tasks are varied as follows:

$$(C_u / T_u) + (C_r / T_r) = U$$

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where,

C_u = worst-case task execution time of task_u,

T_u = period of task_u,

C_r = worst-case task execution time of task_r,

T_r = period of task_r,

U = utilization for both tasks.

However, as discussed for claim 3, the expression $(C_r / T_r) + (C_u / T_u) = [(C_r - N_r) / T_n] + [(C_u + N_u) / T_u]$ is the logical result that would allow the total task utilization for the two combined tasks to remain a constant based on Theorem 1 of Sha (pg. 245). In this expression, both sides of the equation could also separately be referred to as the combined task utilization for the two combined tasks. Please see claim 3 for further discussion.

As per claim 17, it is rejected for similar reasons as stated for claim 2.

As per claim 18, it is rejected for similar reasons as stated for claim 3.

As per claim 21, it is rejected for similar reasons as stated for claim 6.

As per claim 22, it is rejected for similar reasons as stated for claim 7.

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As per claims 23, 24, and 25, Sha teaches of a real-time computing system having a performance specification in accordance with Rate Monotonic Analysis (RMA), comprising:

a memory for storing computer readable code; and

a processor operatively coupled to said memory, said processor configured to perform the functions of claims 1, 8, and 15; respectively.

Sha recites in the abstract of the paper, "This paper discusses how mode changes can be accommodated within a given framework of priority driven real-time scheduling". Clearly this applies to a real-time computing system. Further, the basis for Rate Monotonic Analysis is shown on pg. 245. Further, "Official Notice" is taken that inclusion of a memory and a processor on any computer system is well known and expected in the art. The remainder of the limitations in claims 23, 24, and 25 are the same as those of claims 1, 8, and 15, respectively. Therefore, the discussion of claims 1, 8, and 15 form the basis for rejection for claims 23, 24, and 25, respectively.

Claim Objections

3. Claims 4-5, 11-12, and 19-20 are objected to as being dependent upon a rejected base claim, but would be allowable if rewritten in independent form including all of the limitations of the base claim and any intervening claims.

In order to make this case allowable over the subject matter, claims 1-5 should be rewritten as a separate independent claim. Claims 2 and 3 further clarify the importance of the values of the worst-case execution time and amount of execution time to borrow, and are essential for arriving at how the execution time of the higher priority task and

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period of the lower priority task should be altered such that the schedule remains stable. Further, the equations of claims 2-5 are all related in terms of clarifying how to reallocate execution time from the lower priority task to the higher priority task. Therefore, in order to eliminate any ambiguities, it is requested that claims 1-5 be rewritten in independent form as a single claim including all the limitations therein such that it is completely clear how the reallocation process occurs.

Similarly, claims 8-12 should be rewritten in independent form as a single claim.

Similarly, claims 15-20 should be rewritten in independent form as a single claim.

Conclusion

4. The prior art made of record and not relied upon is considered pertinent to applicant's disclosure.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Syed J Ali whose telephone number is (703) 305-8106. The examiner can normally be reached on Mon-Fri 8-5:30, 1st Friday off.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, John A Follansbee can be reached on (703) 305-8498. The fax phone numbers for the organization where this application or proceeding is assigned are (703) 746-7239 for regular communications and (703) 746-7238 for After Final communications.

Any inquiry of a general nature or relating to the status of this application or proceeding should be directed to the receptionist whose telephone number is (703) 305-3900.


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Syed Ali
March 7, 2003



MAJID BANANKHAH
PRIMARY EXAMINER